ABSTRACTS

NWFSC Watershed Program Open House

Museum of History and Industry
2700 24th East, Seattle, Washington 98112
November 28, 2007

9:00 – 9:20 **An historical template for river restoration in the Columbia River basin.**

T. Beechie, M. Pollock, G. Pess, M. Liermann, M. Pollock, H. Imaki, S. Slover (Conservation Biology, NWFSC), and A. Oakley (Conservation Biology, NWFSC)

Abstract – Identification of restoration targets for riverine and riparian habitats is typically based on locally measured reference conditions. However, no reference sites remain in much of the Columbia River basin, so we define reference conditions based on historical analyses and understanding of landscape processes that define the intrinsic potential of river reaches. Regional geology and post-glacial landscape evolution exert a first-order control on the spatial distribution of reference conditions at the scale of river basins, primarily via controls on channel slope and sediment characteristics. We use existing geological and ecoregion maps to define geomorphic zones (based on geology, topography, and post-glacial history), and show how distributions of intrinsic potentials vary among geologic regions, and how understanding geologic setting helps to define reference conditions and sensitivities to land use. Vegetation patterns exert a second order control on intrinsic habitat potential, via influences on channel form and shade characteristics. To define reference conditions for riparian vegetation, we mapped mid-19th century vegetation conditions based on historical survey notes. We used a combination of complete vegetation mapping in the Walla Walla and Tucannon River basins, mapping of randomly selected vegetation points throughout the Columbia River basin, and simple gap analysis to develop species composition targets for riparian restoration in the Columbia River basin. Both sets of reference conditions guide restoration plans toward actions that are consistent with site potentials.

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9:20 – 9:40 **Landscape characteristics and aquatic habitats.**

E.A. Steel, B.E. Feist, M.B. Sheer (Conservation Biology, NWFSC), A. Odle (SAFS, UW), R. Brannom (Statistics, UW), A. Fullerton, I. Lange (EPA, Washington D.C.), and D. Jensen (Jensen Consulting, Eugene, OR)

Abstract – Linkages among landscapes and rivers have long been recognized but the development of conceptual frameworks and tools for measuring and synthesizing such linkages is relatively recent. We present a series of spatial and statistical analyses to test the hypothesis that landscape condition has a controlling influence on aquatic habitats and biota. We examine the relationship between landscape condition and two types of response variables. (1) We describe relationships between landscape condition and the variability of water flow and temperature patterns as summarized using wavelet analysis. (2) We present simple models that predict salmon population status across multiple watersheds using landscape features. These analyses suggest mechanisms by which large-scale land-use patterns may impact aquatic resources. These correlative analyses in combination with other tools such as scenario-based models can lead the way to a better understanding of how past and future land management decisions have and will continue to define the state of our streams and rivers.

Notes:

9:40 – 10:00 **Mysterious pre-spawn mortality of coho salmon in urbanized streams: there's something in the watershed.**

B. Feist, P. Arnold (USFWS), J. Davis (USFWS) and N. Scholz (Environmental Conservation, NWFSC)

Abstract – Pre-spawn mortality (PSM, ranging from 25-90%) of adult coho salmon (*Oncorhynchus kisutch*) is a phenomenon that has been consistently observed in recent years in urban Puget Sound area streams. By comparison, PSM rates in wild populations of coho salmon are generally <1%. High mortality at this particular life history stage can lead to rapid local population declines an extirpation. In addition, high mortalities of these apparently healthy coho adults is troubling to resource managers, as many of these PSM events occur in habitat restoration sites. The cause of these PSM is a mystery, as the most likely causes (pathogens, acute toxicity, water chemistry and nutrition) have yet to be implicated. The weight of evidence suggests that adult coho, which enter small urban streams following fall storm events, are acutely sensitive to non-point source stormwater runoff containing pollutants that typically originate from urban and residential land use activities. In order to test this hypothesis, we ran a series of spatial analyses where we looked at the correlation between land use and land cover (roads, impervious area, forests, etc.) patterns and PSM rates in 6 different streams. We found that total area of heavy use roads was most correlated with coho PSM rates. We also found that PSM events were closely linked with precipitation patterns. From this, we built a predictive spatially explicit model of coho PSM rates for the eastern Puget Sound basin. The highest PSM rates are clustered around the major metropolitan areas of eastern Puget Sound. In addition, there are large areas in the basin that are expected to experience 35 – 100% PSM rates. Our results have application in both urban planning and salmon habitat restoration activities.

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10:00 – 10:20 **Life history diversity -- causes, consequences, and conservation.**

C. Greene, E. Beamer (Skagit River System Cooperative), J. Hall, and K. Guilbault

Abstract – Life history diversity in salmon has often been viewed as a crucial component of population viability and as a target for recovery, yet our understanding of potential causes and consequences of life history diversity is still in its infancy. In this talk I will present several findings documenting sources of life history diversity in Chinook and sockeye salmon, as well as the responses of salmon populations with varying levels of life history diversity. My findings suggest 1) life history variation is often the consequence of environmental (habitat-related or density-dependent) variation, and 2) life history variation improves population growth over long time periods.

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10:20 – 10:40 **Movement, growth, and survival of juvenile coho salmon and trout in the East Twin River, Washington.**

T. Bennett, R. Wissmar (SAFS, UW), P. Roni, R. Bilby (Weyerhaeuser), T. Quinn (SAFS, UW), E. Prentice (Fish Ecology, NWFSC), S. Downing ((Fish Ecology, NWFSC), and B. Jonasson (Fish Ecology, NWFSC)

Abstract – Restoration of instream habitat for juvenile anadromous salmonids is a common phenomenon in the Pacific Northwest. However, the movements and survival of those fishes are seldom monitored and poorly understood. We implanted Passive Integrated Transponder (PIT)-tags in 2,700 juvenile coho (*Oncorhynchus kisutch*) steelhead/rainbow trout (*O. mykiss*) and cutthroat trout (*O. clarki*) to determine their growth, migration, and overwinter survival in simple (unrestored) and complex (restored) reaches in the East Twin River and its tributary, Sadie Creek. Detections of tagged fish by permanent instream antennas revealed that there was no difference in survival or growth of coho salmon between the simple and complex reaches. However, we detected three times more juvenile coho migrating downstream to the sea in the fall than during the spring smolt season. The fall migrants were predominantly from the East Twin mainstem; Sadie Creek coho tended to remain in-stream to overwinter, where they grew faster and were larger as smolts than coho from the East Twin mainstem. Our results indicated that the effects of habitat or reach scale restoration efforts were difficult to determine and may not be as important to survival as processes happening at the watershed scale in the East Twin River drainage.

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10:40 – 11:00 **Urbanization and marine bird and waterfowl assemblages in greater Puget Sound**

C. Rice, K. Kloehn, J. Karr (SAFS, UW), T. Beechie, and D. Nysewander (WDFW)

Abstract – Abundance of several marine bird and waterfowl species in Puget Sound and adjacent waters has declined markedly in recent decades. Causes of these declines are poorly understood but presumably include many local and remote influences. Although abundances of individual species and species groups are monitored in greater Puget Sound, few analyses of local natural and anthropogenic influences on taxonomic composition have been done. Studying these relationships will not only improve our understanding of birds, but also of the greater Puget Sound ecosystem, and may assist in the development of improved monitoring and assessment tools. We used aerial bird surveys and maps of physical shoreline structure and land cover to explore changes in marine bird and waterfowl assemblage composition across years, oceanographic sub-basins, estuaries, and simple urbanization gradients in greater Puget Sound. Ten years of annual winter surveys (1993-2003), and four years of annual summer surveys (1993-1996) were combined with maps of shoreline segments, and the 2002 winter survey was also combined with 2002 urban land cover within 2 km of the shoreline. Consistent with observed declines in individual population abundance during recent decades, mean taxa richness in summer and winter surveys declined across years in much of the study area. Assemblage composition differed by season and oceanographic sub-basin, but also between urban and non-urban areas, and the relative abundance of some taxa changed along gradients of urban land cover across the study area. Urbanization was associated with increases in the percent frequency of opportunistic and tolerant taxa (e.g., large gulls), and with declines in the percent frequency of wading and shallow bottom feeding taxa (e.g. dabbling ducks, herons, and shorebirds). Percent frequency of diving ducks (the most abundant taxon in the winter surveys) alongshore also declined as urban land cover along shore increased. These results document declining diversity in marine bird and waterfowl assemblages across greater Puget Sound, and demonstrate that local human activity influences assemblage composition.

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11:15 – 11:35 **Marine derived resources in Pacific Northwest streams: scientific insights and management strategies.**

B. Sanderson, H. Coe, A. Goodwin, D. Harstad, V. Pelekis, C. Tran

Abstract – As many streams in which salmon spawn and rear are inherently nutrient poor, the delivery of marine-derived nutrients (MDN) by returning salmon carcasses may be crucial to survival and recovery of juvenile salmon. Because more than 95% of the body mass of salmon is accumulated in the sea, adult returns represents a transfer of nutrients from marine to freshwater and terrestrial habitats. Recent work has demonstrated the importance of this subsidy on the ecology of both terrestrial and aquatic ecosystems. However, the amount of MDN delivered by returning salmonids has been reduced to 6 to 7% of historic levels. To compensate for the loss of this subsidy, several experimental studies examining the potential for nutrient enhancement have been completed or are currently in progress. In addition, excess carcasses from hatcheries are being placed in streams throughout Washington and Oregon. Results from the experimental studies will be useful for guiding future management decisions. But, key questions still remain unanswered about the potential for nutrient enhancement to benefit threatened and endangered populations.

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11:35 – 11:55 **Nutrient limitation in Idaho streams: do inputs of marine derived nutrients matter?**

H. Coe, B. Sanderson, C. Tran, A. Goodwin, D. Harstad, V. Pelekis and K. Macneale

Abstract – The Salmon River basin is home to ESA-listed salmon and steelhead whose recovery is contingent on the existence of fully functioning ecosystems. Because Salmon River streams are generally oligotrophic, marine-derived nutrients delivered by returning salmonids may be important for increasing overall aquatic productivity. Between 2003 and 2007, we collected a suite of data from roughly 20 streams in this basin to examine whether marine-derived nutrients are important for increasing stream productivity and subsequently the survival of wild juvenile salmon. Our first objective was to determine whether low in-stream nutrient concentrations implied nutrient limitation. Nutrient limitation experiments conducted between 2003 and 2006 indicate that these streams are limited by both nitrogen and phosphorus and that periphyton biomass is positively correlated with water chemistry. Our second objective was to determine whether MDN delivered post spawning are incorporated into stream food webs. Stable isotope signatures of various components of the foodweb indicate MDN incorporation is more pronounced in streams with higher numbers of returning salmon. Ultimately, our goal is to link MDN incorporation to increases in aquatic productivity and to growth and survival of wild juvenile salmon and steelhead.

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11:55 – 12:15 **Effects of salmon carcasses on riverine food webs: an experimental field study on the Elwha River.**

S. Morley, H. Coe, M. McHenry (Lower Elwha Tribes Fisheries), J. Duda (USGS), B. Sanderson, L. Ward (Lower Elwha Tribes Fisheries), and S. Dunphy (SAFS, UW)

Abstract – The impending removal of two dams on the Elwha River will restore access by anadromous salmonids to over 90% of the basin. In order to understand how re-colonizing salmon may affect river productivity, we are conducting nutrient limitation and salmon carcass addition experiments above and below the Elwha Dam. Our questions are: (1) is the Elwha River nutrient-limited, (2) will the addition of carcasses result in increased productivity, (3) will these potential changes be amplified above the dam, and (4) how long with these effects persist over time? Our study sites are paired reference and treatment reaches in multiple side channels of the Elwha River. At each site we are collecting data on nutrient limitation, primary and secondary production, juvenile fish use, and the transfer of marine resources through the riverine foodweb. A pilot-scale study was completed in the winter of 2007 with the full-scale experiment currently underway for winter 2008. Our preliminary results suggest that while nitrogen and phosphorous typically co-limit primary productivity on the Elwha River, this limitation is not evident 1-3 months post carcass addition. Periphyton growth in our treatment reach was higher than in the reference reach post carcass placement, and contained a higher proportion of the heavier ^{15}N and ^{13}C isotopes that are indicative of marine resource utilization. Benthic invertebrate and fish sample analysis is not yet complete. This study will help to develop a more mechanistic understanding of how marine nutrients affect freshwater productivity, and do so in the context of monitoring a major watershed restoration effort.

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1:30 – 1:50 **Changes in fish communities following recolonization of the Cedar River, WA, USA by Pacific salmon after 103 years of local extirpation.**

P. Kiffney, G. Pess, J. Anderson (SAFS, UW), K. Burton (SPU), P. Faulds (SPU), and S. Riley (USGS)

Abstract – Man-made barriers block the upstream passage of migrating fishes in many river systems, and barrier removal or circumvention is a major restoration tool used throughout North America. While it is generally assumed that such actions will benefit threatened and endangered fish, the biotic response has rarely been documented. Landsburg Diversion Dam on the Cedar River, WA had blocked upstream migration of Pacific salmon, and number of other native fish species, from 1900 until 2003, when a fish passage facility was installed. We quantified fish density and composition in 10 reaches sub-sampled from 17 km of habitat for two years before and three years after barrier circumvention. Before the fish ladder, resident trout densities increased from downstream (reach 1, 200 m above the dam) to upstream (reach 10, ~17 km from the dam) ranging from 0.01 to 0.12 fish/m^2. This pattern was reversed after the ladder with total salmonid density (salmon and trout) increasing from reach 1 to reach 9 approximately (~14 km from the dam), with the greatest increases occurring from reach 1 to 4 (~8 km from the ladder). The return of salmon to the Cedar River has led to a redistribution of fish largely due to the addition of juvenile coho salmon and local increases in resident trout density.

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1:50 – 2:10 **The influence of population dynamics and landscape condition on Pink salmon (*Oncorhynchus gorbuscha*) re-colonization in the Fraser River, British Columbia, Canada.**

G.R. Pess, T. Quinn (SAFS, UW), R. Hilborn (SAFS, UW), and K. Kloehn

Abstract –We investigate how the establishment of pink salmon (*Oncorhynchus gorbuscha*) populations in the Fraser River, British Columbia, Canada in newly reopened habitats is related to specific life history variation and landscape conditions. Pink salmon in the Fraser River were cut off from most of the watershed between 1913 and the 1940s due to a rockslide at Rkm 209 that altered flow conditions and made adult fish passage impossible (Roos 1996). Local spawning populations above the slide area disappeared. Fish passage facilities developed in the 1940s allowed adult pinks to migrate past the flow barrier and re-colonize the Upper Fraser. We hypothesize self-sustaining populations of colonists can be established when the population growth rate of the colonizing population is greater than one. This occurs when specific population and landscape factors are met. We developed a general population model with multiple parameters to fit observed spawning population growth for each watershed above the historic barrier. We use maximum likelihood techniques to estimate each of the parameters, and likelihood ratios to compare each of the models to determine the one which best fit the observed data. We found that self-sustaining spawning populations of pink salmon can be established within 10 to 30 years of habitat being reopened to access. However, a self-sustaining population in the uppermost watershed was not established during the dataset time period, and instead became a sink population for two of the nearest spawning populations. Differences in colonization rates between the self-sustaining and non self-sustaining populations were related to distance from source population, population growth rate, habitat area, and annual relative population size. The results suggest that the combination of distance from source population, habitat suitability, natural barriers, and population dynamics helped determine the spatial and temporal patterns of Fraser River pink salmon re-colonization.

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2:10 – 2:30 **When the salmon return: Watershed management strategies for above-dam habitat restoration**

A. Fullerton, A. Steel, Y. Caras (King County DNRP), M. Sheer (Conservation Biology, NWFSC), P. Olson (DOE), and J. Kaje (King County DNRP)

Abstract – Prioritizing limited funds for restoration projects designed to improve instream habitat conditions is an important step for recovery of endangered salmonid populations. Here, we apply a tool that predicts the outcomes of alternative watershed management strategies (i.e., methods for prioritizing restoration project budgets) in the Lewis River watershed, southwestern Washington. Additionally, we developed a hypothetical management strategy specific to enhancing habitat for fish populations introduced above dams and compared the results of this new strategy to those of six strategies that had already been modeled. For all seven strategies, we modeled habitat conditions and fish responses that might be expected under two possible future scenarios: (1) passage above hydropower dams for anadromous fish, and (2) expected future trends in both development (i.e., urban growth and road building) and riparian conservation practices. We found that the choice of which strategy performs best was significantly altered when fish were allowed to migrate above dams: in this case, two strategies that focused restoration actions in upper watershed reaches became viable alternatives. When we incorporated expected future trends in development and conservation, we found that the benefits of riparian conservation practices strongly outweighed degradation from urban development. We discuss how predictions from these 7 hypothetical management strategies could be used for developing a real strategy for allocating restoration funds earmarked in the hydropower dam relicensing agreement.

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2:30 – 2:50 **The Bridge Creek watershed restoration and monitoring project – translating restoration research into management actions).**

M. Pollock, C. Jordan (Conservation Biology, NWFSC), C. Volk (Conservation Biology, NWFSC), I. Tattam (OSU) and N. Bouwes (USU)

Abstract – The Bridge Creek watershed restoration and monitoring project is along-term, adaptive management approach to restoring a degraded tributary to the John Day River in eastern Oregon. The goal of the project is to restore enough of Bridge Creek sufficient to cause a measurable population-level impact to the steelhead that utilize the system for spawning and rearing. Bridge Creek is an incised stream in the semi-arid region of the Columbia River basin and is generally representative of the numerous incised streams that exist throughout the region. Using innovative techniques, we seek to alter sediment transport processes in the system in order to cause the incised stream to aggrade and reconnect to its former floodplain. We have studied the watershed for four years now, gathering background information on fishes, hydrology, geomorphology, temperature regimes, aquatic invertebrates and riparian vegetation. These data will be used to assess the changes in the system resulting from the restoration actions. Once the restoration actions are complete in 3-4 years, we will continue to monitor for another 10-12 years to observe physical and biological system recover. This project should provide guidance to restoration approaches for the numerous incised streams that exist throughout the Columbia River basin.

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2:50 – 3:10 **Escapement estimation using imaging sonar in Western Washington: when, where and how**.

M. Liermann and D. Rawding (WDFW)

Abstract – Escapement estimation is a key component of salmon population management. It is used both for deriving population parameters with which management goals are set, and for monitoring the population status to determine whether or not these goals have been met. Traditional approaches to estimating escapement are based on visual counts of redds, fish on the spawning grounds, and carcasses. While these methods provide reliable estimates in many basins, there are number of populations for which visual counts are unreliable due to high turbidity or difficulty accessing the spawning grounds. In addition, these counts are often based on a subsample of the total spawning area and spawning period, requiring expansion to provide estimates. One alternate approach to estimating escapement is to use imaging sonar to enumerate fish passing a point low in the river below the spawning areas. This approach has been used extensively in Alaska and British Columbia. Imaging sonar uses pulses of sound to construct a 2 dimensional image of the water column, with sufficient resolution to clearly identify individual fish and estimate lengths. We are currently evaluating two types of imaging sonar (DIDSON and Blueview) in a number of different rivers in Western Washington. Our goal is to determine where, and when this technology is feasible and compares favorably to other escapement estimation approaches in terms of accuracy, and cost. Our initial results suggest that there are systems in Western Washington for which this approach can be effective. However, problems with site security, power generation, and high flows make installation in most rivers challenging.

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3:10 – 3:30 **Estimating salmon and steelhead response to watershed restoration: How much is enough?**

P. Roni, G. Pess, T. Beechie, and S. Morley

Abstract – A critical need for recovering listed salmon populations is an estimate of potential increases in salmon production from different restoration actions. Using existing data from evaluations of habitat restoration techniques, we estimated the average and standard error of coho and steelhead parr and smolt production for wood placement, boulder placement, constructed logjams, constructed side channels, reconnected floodplain habitats, and culvert removal. We then developed three hypothetical restoration strategies using different combinations of techniques and applied these to small, medium and large watersheds to predict the increases in parr and smolts for each strategy. Wood and boulder placement increased coho parr densities by an average of 0.59 to 3.19 fish/m of stream and coho smolt densities by 0.21 to 0.53 fish/m. These same actions increased steelhead parr by -0.05 to 0.30 fish/m, and steelhead smolts by 0.04 to 0.10 fish/m. Constructed side channels and reconnection off-channel areas increased coho and smolts by 0.32 and 0.45 fish/m and steelhead 0.32/m. When these numbers were combined with different restoration scenarios, total fish production varied by watershed size and restoration type with most of the increases in parr and smolt production from the small and medium watersheds coming from constructed groundwater channels and wood placement. In contrast, in the large watershed most of the increase came from floodplain restoration (reconnection) for coho and from groundwater channels and constructed logjams for steelhead. The total percentage of a watershed that needed to be restored to detect a 25% change in steelhead or coho salmon smolts ranged from 9% to 56% depending upon species and watershed restoration scenario. These results demonstrate that a considerable amount of habitat restoration is needed within any one watershed to increase fish numbers to a level suitable for salmon recovery or to be detected by monitoring.

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